

Mobile learning for history and cultural heritage education in Indonesia: a systematic review

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Abstract: History education in Indonesia faces declining student engagement despite the increasing vulnerability of historical and cultural heritage. Mobile technologies have been proposed as a potential solution, yet empirical evidence remains fragmented. This study reviews empirical research on the use of mobile devices for history and cultural heritage learning in Indonesia, focusing on research design, technology, pedagogy, and learning outcomes. Following the PRISMA 2020 framework, a systematic search was conducted in Scopus on 22 December 2025 using Boolean search terms based on the PICOS framework. Of 5,952 records identified, 14 studies met the inclusion criteria after removing duplicates, ineligible records, and studies that did not meet the specified requirements. Eligible studies were open-access, peer-reviewed, English-language articles published between 2021 and 2025 and based on primary field research in Indonesian educational contexts. The findings indicate that augmented reality (AR) and mobile application development were the dominant technologies, while most studies focused on design and development. Overall, the studies reported positive effects on student motivation, usability, and knowledge acquisition. However, assessments of historical thinking skills and long-term learning outcomes were rarely conducted. This review provides an evidence map of the field and highlights the need for theory-based, controlled experimental research with long-term outcome measurements.

Keywords: Mobile learning, History education, Cultural heritage, Augmented reality, Systematic literature review

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INTRODUCTION

Digital transformation has brought about a significant reconfiguration of the way societies generate knowledge, transmit that knowledge, and absorb it in relation to history. At the core of that reconfiguration lies the role of mobile devices. Most populations of the Global South depend mainly on smartphones to connect with the worldwide web. Hence, the use of portable devices for education and the communication of culture is not just an optional tool, but a foundational pillar of schooling provision. Mobile-mediated education is not an extra offering but, for example, a structural component of Indonesian education that is being provided (Aman et al., 2020); the fact that Indonesia shows such a stark picture of this phenomenon will be further clarified. Indonesia is a perfect

example of this: an uneven distribution of people on various islands across the island nation, lack of proper broadband services in the region, and nearly widespread mobile coverage all contribute to the situation that small electronic devices are the primary means of the dissemination of educational and cultural contents (Permatasari et al., 2020). Recently, a growing number of academics have devoted their research to uncovering how tradition, culture, and learning through technology influence one another. Such efforts have come about due to a larger understanding that technology-based environments are as important as any other for culture transmission as they are for academic results, in particular (Yuki et al., 2025).

Among history's major fields of study, history education as an area within educational history is at a sort of crossroads. History lessons are often described as dull and dry memory-based subjects with a lot of chronological and textbook narration by the students. History teachers also find it hard to convert abstract time materials into experiences that would keep young people interested (Utami et al., 2019). The underlying issue however is not the teaching method itself. One of Indonesia's major heritage assets is its tangible and intangible heritage like regional scripts, textiles, performing arts, colonial-era buildings, museum collections, etc. This heritage continues to be transmitted in various ways mainly by communities whose young members have started living with technology and seeing the world via the screen. So, lack of participation from the students in the history class, besides not being an issue of the lesson itself, is further weakening an already flimsy means of culture transmission through heritage (Budiman & Wati, 2019). Recent work on heritage education in eastern Indonesia sees this as a question of sustainability rather than curriculum and says that a change for the better in teaching is a step towards the continuation of heritage (Mansyur et al., 2025).

Finding solutions to this matter of cultural education has led to research, some of it done as far back as almost a decade ago. At first, the Indonesian scholars focused mainly on the development of location-sensitive apps and mobile tours that could tell visitors stories about historical places. For example, apps that used geolocation to guide tourists, and mobile apps that would introduce historical monuments to the people of urbanised regions (Priandani et al., 2017; Rupilu & Santoso, 2018). At the same time, another approach involved using marker-based augmented reality which was quite effective in showcasing material heritage through examples such as the representation of philosophical meaning inherent in batik motifs or the creation of regional musical instruments in such way that an interested audience who might not ever have a chance to see the originals would be very entertained at least (Widiaty et al., 2018; Juniawan et al., 2019).

Several groups worked on a way to enrich the historical experience. They did this by placing a layer of content that is related to the users' orientation, or by interpreting the storytelling element into a form that is playable through one's mobile phone (Galih et al., 2019; Sabilarussyda et al., 2017). At the same time, they also tested the use of AR to showcase motifs in region-specific textiles and interactive script learning that involved identifying gestures. Another way that was less immersive to study was to find out how students use e-books as a medium for learning history (Seran Bria et al., 2018; Dyah Puji Astuti et al., 2018; Imansari et al., 2019). Despite being distinct from one another, together the studies paved the way for the application but were almost always published in the engineering conferences with a sole focus on showcasing the new technological methods. Within the last five years, we have observed a very clear shift in intention. Instructional goals for the first time have been addressed explicitly in different immersive or game-based approaches: there have been mobile platforms' historical learning role-playing games, serious games, which have been re-created national histories like the battle of Surabaya -, and gamified android apps designed after curricula topics all of which are being put forward as alternatives to expository teaching (Kusuma et al., 2021; Rinaldi et al., 2022; Hermawan & Arizona, 2024). Since cross-platform development frameworks significantly reduce the game development expenses, we are now able to share some success stories related to history content based on the Flutter. On the other hand, augmented reality has developed

from a technology that was based on the static marker to a system that is telling stories as well as it can do simultaneous localization and mapping; thus, the temple reliefs, monuments and the shadow puppet heritage of Indonesia are now able to narrate themselves (Enrico et al., 2024; Kurniawardhani et al., 2024; Mohd Nizam et al., 2025; Pramono et al., 2025). In addition to that, these same methods have been extended by cross-disciplinary designers to performing arts and ethnomathematics; that indicates that heritage learning through mobile technology is getting together into a clearly identifiable line of research (Maulana et al., 2024; Rochmadi et al., 2023).

A first deficiency is simply this: the most commonly used way to report is still to describe the artwork. This typically involves building a prototype then exposing a usability or acceptance measuring tool to it concluding that it is a success without learning being the main point or measurement of it. Research that brings the user to see the augmented reality of a puppet character, a traditional dish, or a museum object generally ends after getting scorecards and doing the functional tests. It ignores both pre-and post-test instructional comparisons or a report of what learners understood after all (Dewi and others, 2019; Weking & Santoso, 2020; Listyorini & Subakti, 2023). Even where the framing of an educational context is overt, the output measures are often only confined to satisfaction and utility perceived, as in cases of heritage tourism designs made by games, pandemic-era museum apps or tools based on artificial intelligence for identification of traditional architecture (Widarti & Emanuel, 2020; Puspasari et al., 2020; Winianti et al., 2022). A second gap pertains to theory and method. Only a very few of the Indonesian studies are based on well-known theories or frameworks of historical cognition, while the elements like historical thinking, source evaluation, temporal reasoning, and historical empathy largely are not reflected in the instruments of measurement, even for research aiming at cultivating cultural understanding (Permatasari et al., 2023). When theory is actually drawn on, it tends to be borrowed from fields as diverse as technology-acceptance research or visit intention rather than being history education focused. As a result, concepts like attitude, intention, and perceived value substitute for learning or studying in general (Wahyuni et al., 2021; Jovanka et al., 2023).

There are few comparative or controlled study setups, and research samples are commonly quite small and only related to that specific site, and results are spread across computing conferences, digital humanistic gatherings, tourism-oriented publications, and even education journals, which prevents the building of a coherent and comprehensive knowledge base or synthesis (Hiererra et al., 2022; Pramatha et al., 2021). We also notice that existing overview research papers are a double-edged sword. They make things even harder for the user who has very little time, very short attention span, or, just like us, needs it for their studies or their jobs, because what is available is not really an evaluation of the evidence (i.e., the research outcomes). They are just maps of who has been doing what research. None can be said even remotely specifically related to Indonesian education in the context of history (Yuki et al., 2025).

This is thus a case both for timeliness and practicality in synthesising these elements. Educational policy shift in Indonesia provided an opportunity to expand learning activities with project-based, contextual and locality-driven inquiry in history as a subject, which is how mobile technologies are supposed to help. Yet, following the pandemic experience, schools are still left with a 'mobile-first' teaching approach that is, at best, a very loosely interpreted phenomenon (Jamiludin & Darnawati, 2022). Meanwhile initiatives in digital heritage are continuing to grow at a great speed without any shared empirical criterion, whereas information to teachers about the impact of different designs of mobile tools on historical understanding is simply missing (Febriansari et al., 2021; Permatasari et al., 2020).

Without a rigorous, analytical review that sorts primary studies, evaluates their methodological reliability and visualizes what has and has not been measured, it is not even possible to think about shifting our focus from proving that certain techniques work to showing that they really work

(Mansyur et al., 2025). We have therefore done a synthesis on the peer-reviewed and open-access paper evidence of research carried out in Indonesia from 2021 to 2025, assessed it using a design-sensitive tool, and brought about a synthesis through these three points of inquiry. Firstly, our study is original because we only looked at the research that has been undertaken with the local setting as a backdrop both educationally or in the heritage. Secondly, we were critical of them, not just a mere count. Thirdly, we have reported the constructs or variables that the researchers have failed to identify and measure.

RQ1: What are the characteristics and trends of mobile learning research in Indonesian history and cultural heritage education with respect to publication year, geographical distribution, educational level, and research design?

RQ2: How is mobile learning implemented in this context, and which mobile technologies, pedagogical approaches, and learning activities are most frequently employed?

RQ3: What effects does mobile learning have on learners' outcomes, engagement, motivation, and historical or cultural understanding?

METHOD

A systematic literature review method was adopted as the main aim is not to generate new empirical data but to explore, assess, and synthesised an existing body of literature that relates to the quality, state, and convergence of primary evidence that a reader may have already been able to come up with independently. This review method allows for locating, appraising, and synthesizing the findings while at the same time being fair with no selection bias that one normally gets when reading a narrative review. Moreover, it is highly suitable in a situation when a literature is spread over several fields and this is exactly what happened in our case (Tranfield et al., 2003). In our case both the planning and writing were done in accordance with Transparent Review Reporting (EXPRO) by Liberati et al., (2009) and we actually implemented a PRISMA 2020 flow document that defines how records are accounted for, what eligibility criteria are used, and what synthesis reporting is used in this paper from the beginning to the end (Page et al., 2021).

We had already decided on the research questions before we actually started the paper, and for our purposes, it makes good sense to decompose the main research question by identifying the key search terms for the review that we want to carry out. In fact, this kind of research often ends up with people getting confused about which papers they should read or why they selected a particular paper, if they are just told the overall questions rather than the breakdown of the question that will help them find the right paper for the right question. Our main tool for breaking down the research question, which can be used either as part of the initial planning or later for quality checking of the final version of the manuscript, is called PICOS (Population, Intervention or Issue under study, comparison, outcomes, and study design). A study that looks different from all the others should still be able to have its key elements captured by such a method. We have done so by first writing each component of the research question separately and then making the search terms that represent each one. The result of this has been summarized in Table 1, while further details of the individual items can be found either below or within the text of the paper.

A major limitation of the traditional PICO (Population, Interventions, Comparisons, and Outcomes) model of decomposition is its inability to cover certain types of research studies such as systematic reviews or observational study designs, which we had hoped to include in our paper. Since there will likely be quite a few designs of a study at the end of this paper, the use of the PICOS framework which explicitly specifies the study type seemed the most appropriate way to go for our case. A few more advantages of this approach are that it helps to minimize variability in the

definition of different terms among team members as well as across team members. As a result, there should be no need to refer back to the original decomposition to re-clarify a term.

Table 1. PICOS Decomposition of the Review Questions

Element	Definition adopted in this review	Representative search terms
Population (P)	Learners in Indonesian formal education and visitors in Indonesian museum or heritage settings engaging with historical and cultural content	student, <i>learner</i> , pupil, <i>visitor</i> , Indonesia
Intervention / Interest (I)	Learning mediated by handheld mobile devices, including mobile applications, mobile augmented and virtual reality, mobile games, and QR-code-mediated access	"mobile learning", "m-learning", "mobile app", <i>smartphone</i> , "augmented reality", "QR code"
Comparison (C)	Conventional non-mobile instruction, printed materials, or static museum display where a comparator was reported; no comparator required for inclusion	"conventional", "traditional", "printed", "control group"
Outcome (O)	Learning achievement, historical and cultural understanding, engagement, motivation, usability, and technology acceptance	outcome*, achievement, engagement, motivation, usability, acceptance
Study design (S)	Primary empirical studies of any design, including design-and-development research reporting learner evaluation	experiment, <i>survey</i> , "mixed method", development, evaluation

Note. The PICOS framework was used solely to structure the search strategy and is distinct from the quality appraisal procedure described in Section 2.6.

Each PICOS element was translated into a cluster of synonyms, and the clusters were combined with the Boolean operator AND while synonyms within a cluster were combined with OR. The final string was: TITLE-ABS-KEY (("mobile learning" OR "m-learning" OR "mobile app*" OR "mobile application*" OR "mobile device*" OR *smartphone** OR "mobile game*" OR "augmented reality" OR "virtual reality" OR "QR code*") AND (histor* OR heritage OR museum* OR archaeolog* OR "local wisdom" OR "traditional cultur*") AND (educat* OR learn* OR teach* OR instruction* OR pedagog* OR student*)) AND (LIMIT-TO (AFFILCOUNTRY , "Indonesia"))

Truncation was applied to capture morphological variants without inflating the string: histor retrieves history, historic, historical, and historiography; educat* retrieves education, educational, and educator; museum** retrieves both singular and plural forms. Phrase searching with double quotation marks preserved multi-word concepts such as "mobile learning" and "local wisdom", which would otherwise fragment into unrelated hits. The field code TITLE-ABS-KEY restricted matching to title, abstract, and indexed keywords, thereby excluding records in which the concepts appear only incidentally in reference lists or full-text body matter. The affiliation-country limiter operationalised the geographical scope of the review at the point of retrieval rather than at screening.

The string was piloted iteratively. An initial version omitting the third concept cluster returned a large volume of purely technical records concerning heritage digitisation without any instructional dimension; adding the education cluster substantially improved precision. A second pilot that included generic terms such as "culture" without truncation control produced substantial noise from organisational-culture and cell-culture literatures and was discarded. The version reported above was adopted as the final search.

Scopus served as the sole database for record identification. It was selected because it indexes the regional and international outlets in which Indonesian educational technology research is predominantly published, provides structured document-type, source-type, publication-stage,

open-access, and affiliation-country metadata necessary to operationalise the eligibility criteria at the retrieval stage, and applies a consistent quality threshold for source inclusion. The search was executed on 2 August 2026 and returned 5,952 records. No supplementary databases, grey literature sources, or citation-chaining procedures were employed; this decision is revisited in Section 4.5.7. Eligibility was defined a priori and applied uniformly across screening stages. Table 2 states the criteria.

Table 2. Inclusion and Exclusion Criteria

Criterion	Inclusion	Exclusion
Publication year	Last five years (2021–2025)	Published before 2021
Document type	Article	Conference paper, review, book chapter, data paper, editorial, note
Language	English	Non-English
Country	Indonesia (affiliation country and study context)	Studies conducted wholly outside Indonesia
Source type	Journal	Conference proceedings, book series, trade publication
Publication stage	Final	Article in press
Access	Open access	Subscription-restricted, full text unavailable
Topical relevance	Mobile-device-mediated learning applied to historical or cultural heritage content	Mobile technology in unrelated domains; heritage digitisation with no instructional purpose
Participants	Reports learners, students, teachers, or museum visitors engaging with the intervention	Purely technical evaluation with no human participants in a learning role
Study type	Primary empirical study, including design-and-development research with learner evaluation	Bibliometric analyses, secondary reviews, conceptual papers

Stage-wise selection was used, and there were three stages. In the first identifying stage, 5, 952 retrieved documents were exported and then deduplicated; this process resulted in the elimination of 14 duplicates that arose either due to indexed errors or from two entries for the same document. Afterward, language, publication type, language source, and author's country, among other aspects, were filtered automatically. This was done within the database interface so that all ineligible documents could be filtered out quickly, and this helped to reduce further by 5, 783 documents leading to the identification of only 155 documents that are to be screened manually in the second step.

A manual review and screening of titles and abstracts against the document-type and the publication period criteria in the second screening stage excluded 110 articles. In the third eligibility stage, the full texts of the 45 remaining articles were obtained and evaluated regarding whether they fit the subject matter, the kind of participants involved, and the type of study criteria, a result of which was the exclusion of a further 31 articles. Fourteen studies were able to meet all of these criteria and, thus, were taken to be synthesized. Screening decisions were tracked using a well-structured form of the decision matrix for which reasons were provided for each deletion so that records could be tracked back to the stage where they were filtered out. In addition, in the case of those borderline records which had elements of heritage content yet had an ambiguous intention of instruction in general, we went to the full text and applied the participant criterion as a decisive factor. As it was pointed out in Section 2.2 and the formulation of the PICOS-based search was separate with an independence of the quality appraisal, in each one of the articles the quality check was done separately by means of the Mixed Methods Appraisal Tool (MMAT), a version 2018.

This method has been taken due to its ability to evaluate a wide variety of different research designs that are most common in literature including qualitative, quantitative descriptive, quantitative non-randomized, and mixed methods research. In this respect, Hong et al., 2018 have given a good account of this. A three-step process was undertaken. Initially, each project was divided accordingly to type based on methods described in abstract and full text. Then, the MMAT checklist with five criteria related to each design category was completed for that study, each item of which the researcher answered " YES ", " Can't tell", or "NO". In particular, the method described was used as a replacement when a project did not fall within MMAT categories. Mostly, it concerned reports of development-and-testing where a learner sample is missing. The Joanna Briggs Institute Critical Appraisal Checklist that is equivalent in such case and this substitution was explicitly noted. For this, the scoring was done as: Yes = 1; Can't tell or partial = 0.5; and No = 0.

Table 3. Quality Assessment Summary Using MMAT Version 2018

Author(s), Year	Study design	Q1	Q2	Q3	Q4	Q5	Total	Quality
Bramantya et al., 2021	Qualitative	Y	CT	Y	CT	CT	3.5 (70%)	Medium
Jamiludin & Darnawati, 2022	Mixed methods	Y	Y	Y	Y	CT	4.5 (90%)	High
Sudipa et al., 2022	Quantitative descriptive	Y	CT	Y	Y	CT	4.0 (80%)	High
Agustini et al., 2023	Quantitative descriptive	Y	Y	Y	Y	Y	5.0 (100%)	High
Martha et al., 2023	Quantitative descriptive	Y	CT	Y	Y	N	3.5 (70%)	Medium
Maulana et al., 2023	Quantitative descriptive (JBI substitution)	CT	N	CT	CT	N	1.5 (30%)	Low
Purwati et al., 2023	Quantitative descriptive	Y	Y	Y	Y	CT	4.5 (90%)	High
Safitri et al., 2023	Quantitative non-randomised	Y	Y	Y	CT	CT	4.0 (80%)	High
Tajuddin et al., 2023	Quantitative descriptive	Y	CT	CT	Y	CT	3.5 (70%)	Medium
Hakim et al., 2024	Quantitative non-randomised	Y	Y	Y	CT	CT	4.0 (80%)	High
Yudhanto et al., 2024	Quantitative descriptive (JBI substitution)	Y	CT	CT	CT	N	2.5 (50%)	Low
Yudhawasthi et al., 2024	Quantitative descriptive	Y	CT	CT	CT	CT	3.0 (60%)	Medium
Zaliluddin et al., 2024	Quantitative descriptive	Y	CT	CT	Y	CT	3.5 (70%)	Medium
Khan et al., 2025	Quantitative non-randomised	Y	Y	Y	Y	Y	5.0 (100%)	High

Note. Y = Yes (1.0); CT = Can't tell or partial (0.5); N = No (0). Quality categories: High $\geq$ 80%, Medium 60–79%, Low < 60%. Mean appraisal score = 3.71 of 5 (74.3%). High = 7 studies; Medium = 5; Low = 2.

The researchers created a consistent data-extraction form to be used on all of the eligible studies. Information about the following topics was captured: the full reference of the paper (authors, publication year, title of the article and the journal it is published in, the volume and issue number of the journal, the page range, and the DOI number); the location of the research work carried out (at the province level), the level and context of education; the traits of the subjects and group size; details of the study design and the methods for collecting the data; the specification of the mobile technology or the intervention along with delivery platform and interaction modality.

Also, the pedagogy design and structure of the teaching-learning activity; the outcome dimensions that were measured and the tools used to measure them; and the key findings of the study. In the case of fields where a source document didn't provide the relevant information, it was not assumed or filled with an appropriate replacement but just noted as not mentioned and the same convention applies to the result tables. Data were taken straight from the full text papers and values reported in the meta-analysis reflect the numbers that were given by the original authors. To provide more thorough information about the subject at hand a conceptual analysis was developed. We first

looked at the terms provided by the authors themselves as well as the subjects given to each document by the databases and we got rid of any differences related to case or misspelling. The remaining terms were grouped together based on meaning or meaning close enough when terms that were similar enough.

Then we marked whether each piece of evidence mentioned or did not mention each one of the resulting categories under the four aspects mobile technology, heritage content, pedagogical design and learning outcome. To get the concept frequency number we added up how much the idea was mentioned. Lastly, we put all co-occurring concepts together in a four-cluster concept map in which the size of the points was the same as the number of times they came up. We have to consider several limitations. The first, of course, would be that the data is not from one large pool but rather different sources that are all quite small in size which could lead us making some errors as to how the terms are connected etc. Also, no limits on how often a term was mentioned or what is considered a good enough grouping were imposed and no normalization of the strength of association was applied. As this only describes this corpus the map must not be interpreted as a bibliometric estimate of the wider area.

In addition to the narrative review, we also did the three stages of a thematic analysis as explained in Thomas & Harden (Thomas & Harden, 2008). First, every claim made. This article followed the PRISMA 2020 Statement and checklist during the review process by covering the title, structured abstract, research objective and rationale, selection criteria, searching, and sources of information, data-capture, and data-collection processes, risk-of-bias assessment of research papers, synthesis techniques used, the number of search and study results, the presentation of the selected articles including their features and appraisal, outcomes of syntheses, the interpretation of the findings, and the weaknesses (Page, et al., 2021). The flow of records, as displayed in Section 3, is identical to the counts given in the abstract, the figure 2, and the section 4 of the article. The figure 1 of the report depicts a flow diagram of the process of a record through the steps of identification, screening, eligibility, and inclusion and this was created as a PRISMA flow diagram. (Page, et al. 2021) has a good description about how to do the PRISMA 2020 flow-diagram.

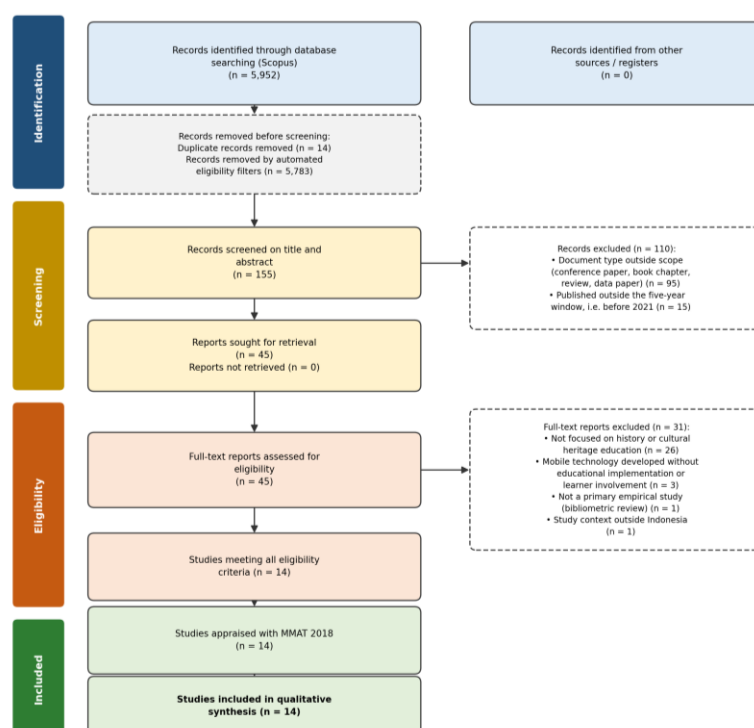


Figure 1. PRISMA 2020 Flow Diagram of the Study Selection Process

RESULTS AND DISCUSSION

The Scopus search returned 5,952 records. Deduplication removed 14 records, and the automated eligibility filters for language, source type, publication stage, open-access status, and affiliation country removed a further 5,783 records, leaving 155 records for manual screening. Title and abstract screening excluded 110 records: 95 because their document type fell outside the eligibility criteria, comprising 90 conference papers, one book chapter, one data paper, and three reviews; and 15 because they were published before 2021 and therefore fell outside the five-year window. The full texts of the remaining 45 articles were assessed for eligibility, of which 31 were excluded. Twenty-six addressed domains unrelated to historical or cultural heritage education, predominantly health, clinical informatics, agriculture, business, and transportation. Three reported mobile technology developed without any educational implementation or learner involvement, comprising two image-classification systems and one artificial-intelligence identification tool. One was a bibliometric mapping rather than a primary study, and one was situated outside Indonesia. Fourteen studies met all eligibility criteria and were included in the synthesis, all of which were retained after quality appraisal.

The fourteen included studies were published between 2021 and 2025 across thirteen distinct journals, with the International Journal of Interactive Mobile Technologies, Asian Journal of University Education, and the International Journal on Advanced Science, Engineering and Information Technology each contributing two articles. Table 4 summarises the studies; Table 5 classifies them by theme, technology, and outcome.

Table 4. Summary of the Fourteen Included Studies

Author(s), Year	Full title	Journal	Context and participants	Research design	Key findings
Bramantya et al. (2021)	Engaging Students in Oral History in the Archival Science Study Program, Vocational College, Universitas Gadjah Mada	Journal of Archival Organization	Archival Science students, Vocational College, Universitas Gadjah Mada (Yogyakarta)	Qualitative descriptive programme study	Oral history archives accumulated since 1997 are disseminated publicly through the ARISAN mobile application, supporting knowledge transfer and the use of oral testimony as historical evidence in coursework and community recording.
Jamiludin & Darnawati (2022)	E-learning on History learning: Aspect of material, teacher, learning environment, and student	International Journal of Evaluation and Research in Education	25 history teachers and 161 senior high school students, Kendari	Mixed methods (questionnaire and interview)	Students prefer direct classroom instruction; unreliable networks and the absence of laptops or smartphones are the principal barriers; teachers favour asynchronous delivery through Google Classroom, WhatsApp, and YouTube.
Sudipa et al. (2022)	Developing Augmented Reality Lontar Prasi Bali as an E-learning	Journal of Wireless Mobile Networks, Ubiquitous	86 respondents, Balinese lontar prasi	Research and development with User	The AR application scored above average on pragmatic, hedonic, and overall quality (excellent category), and higher

Author(s), Year	Full title	Journal	Context and participants	Research design	Key findings
Agustini et al. (2023)	Material to Preserve Balinese Culture	Computing, and Dependable Applications	manuscript heritage	Experience Questionnaire testing	smartphone specifications yielded faster loading response times.
	The Effect of Augmented Reality Mobile Application on Visitor Impact Mediated by Rational Hedonism: Evidence from Subak Museum	International Journal of Advanced Computer Science and Applications	241 visitors, Subak Museum, Bali	Quantitative survey with mediation analysis	AR media content quality is the strongest direct determinant of visitor impact, whereas system and information quality operate only indirectly, fully mediated by rational hedonism and experienced satisfaction.
Martha et al. (2023)	User Interface Design of Jaipong Dance Applications for Elementary School using the User-Centered Design (UCD) Method	International Journal on Advanced Science, Engineering and Information Technology	15 public elementary school pupils, Ciamis, West Java	User-centred design with QUIM usability evaluation	The Jaipong dance application achieved an average usability score of 91% (excellent), and 86.7% of application users understood the material well compared with 33.3% of pupils using video alone.
Maulana et al. (2023)	Introduction to Sumba's traditional woven fabric motifs based on augmented reality technology	Indonesian Journal of Electrical Engineering and Computer Science	Sumba woven textile heritage; marker-based catalogue (no learner sample reported)	ADDIE development with technical performance testing	3D textile models render from a minimum marker distance of 20 cm within a 0°–45° reading angle, with a mean detection duration of 0.056 s; no learner outcome was measured.
Purwati et al. (2023)	History Students' Readiness in Using QR Code Based E-Job Sheet	International Journal on Informatics Visualization	140 history education students, Universitas Negeri Padang, West Sumatra	Quantitative descriptive survey	More than half of the students knew what an e-job sheet was but two-thirds had never used one, and two-thirds reported that campus internet and personal smartphones could not adequately support QR-code-based use.
Safitri et al. (2023)	Developing Mobile Learning Activity Based on Multiple Learning Objects for the South Sumatra Local Wisdom Course	Asian Journal of University Education	Fifth-semester History Education undergraduates, Universitas Sriwijaya, Palembang	ADDIE research and development with pre-test and post-test	The multiple-learning-object mobile activity was validated as ready for classroom implementation, and post-test scores improved substantially, with nine students scoring 86–100 and seven scoring 70–85 and none below.

Author(s), Year	Full title	Journal	Context and participants	Research design	Key findings
Tajuddin et al. (2023)	Baluk olas (Eighteen) Sasak Scripts in the Digital Era Based on the Mobile Games	International Journal on Advanced Science, Engineering and Information Technology	Elementary and junior high school pupils learning Sasak script, West Nusa Tenggara	Multimedia Development Life Cycle development with community survey	52.86% of parents reported that learning the Sasak alphabet is difficult; the Android game received a 76.67% favourable rating for user-friendliness and raised pupils' interest in the Baluk Olas script.
Hakim et al. (2024)	Exploring Colonial Heritage (EXCOTAGE) Application as a Mobile Technology-Based History Learning Education	International Journal of Interactive Mobile Technologies	11th-grade social science students, MAN Kota Pasuruan, East Java	ADDIE research and development with validator and user questionnaires	The EXCOTAGE colonial heritage application was judged valid, appealing, and aligned with current learning technology, and was rated highly effective in expert and user assessment.
Yudhanto et al. (2024)	Designing and Manufacturing Keris Nusantara Virtual Museum with Agile for VR Methods	Journal of Engineering Science and Technology	40 respondents, Museum Keris virtual museum	Agile for Virtual Reality development with questionnaire	A mobile virtual-reality museum produced through the Agile for VR method delivered interactive 3D heritage media, with requirements derived from user stories, storyboards, and interactivity analysis.
Yudhawasthi et al. (2024)	QR Code Automatic Guiding Plus of Museum UGM Indonesia: Visitors' Survey from the Concepts of Museum Communication and Niels Windfeld Lund's Complementarity Document	Proceedings from the Document Academy	Visitors of Museum Universitas Gadjah Mada, Yogyakarta	Visitor survey within a museum communication framework	QR-code automatic guiding delivers navigation, guidance, and collection narration via smartphone, and visitor engagement depends on positive information-retrieval experience across spiritual, educational, recreational, and ukhuwah dimensions.
Zaliluddin et al. (2024)	Engaging Teens in History through a Mobile Game Utilizing the Fisher-Yates Shuffle Algorithm and	International Journal of Interactive Mobile Technologies	Adolescent learners of local history	Development study with user survey	The mobile history game combining the Fisher-Yates shuffle algorithm with Honeycomb UX obtained an average user score of 3.75 and was reported to increase adolescents' historical

Author(s), Year	Full title	Journal	Context and participants	Research design	Key findings
Khan et al. (2025)	Honeycomb UX Design From Static Displays to Interactive AR: Evaluating the Effectiveness of an AR App for Gen Z and Alpha in Museum Pusaka	Journal of Theoretical and Applied Information Technology	40 and 86 students, Museum Pusaka, Taman Mini Indonesia Indah, Jakarta	Quasi-experimental with control group, pre-test and post-test, ANCOVA	knowledge and interest in local history. The AR mobile application containing 3D models and interactive content produced significant improvements in both learning outcomes and engagement relative to traditional printed materials.

Note. Titles are reproduced in full from the source records. Sample sizes and percentages are those reported by the original authors.

Table 5. Classification of Included Studies by Theme, Technology, and Outcome

Author(s), Year	Study site (province)	Research design	Thematic focus	Mobile technology / intervention	Reported outcome domain
Bramantya et al. (2021)	Special Region of Yogyakarta	Qualitative descriptive	Oral history and archival practice in higher education	ARISAN mobile archival repository application	Access to and dissemination of oral history evidence; integration of archival sources into coursework
Jamiludin & Darnawati (2022)	Southeast Sulawesi	Mixed methods	Perceptions of technology-mediated history instruction	Mobile-accessible e-learning platforms (Google Classroom, WhatsApp, YouTube)	Learner and teacher perception; infrastructure barriers; preference for asynchronous delivery
Sudipa et al. (2022)	Bali	Quantitative descriptive	Preservation of Balinese manuscript heritage	Marker-based mobile augmented reality	User experience (pragmatic and hedonic quality); system responsiveness
Agustini et al. (2023)	Bali	Quantitative descriptive (survey with mediation)	Museum visitor learning and experience	Museum augmented reality mobile application	Visitor impact; experienced satisfaction; rational hedonism
Martha et al. (2023)	West Java	Quantitative descriptive (usability)	Traditional performing arts in primary education	Purpose-built mobile learning application (UCD)	Usability; comprehension of material relative to video-only learning
Maulana et al. (2023)	East Nusa Tenggara	Quantitative descriptive (technical)	Textile heritage motifs and their narratives	Marker-based mobile augmented reality catalogue	Technical performance only; no learning outcome reported
Purwati et al. (2023)	West Sumatra	Quantitative descriptive (survey)	Digital readiness in	QR-code-based electronic job sheet	Readiness; prior experience; adequacy of

Author(s), Year	Study site (province)	Research design	Thematic focus	Mobile technology / intervention	Reported outcome domain
Safitri et al. (2023)	South Sumatra	Quantitative non- randomised (pre-post)	history teacher education Local wisdom and regional history in higher education	accessed by smartphone Mobile learning activity based on multiple learning objects	supporting infrastructure Learning achievement; product validity and readiness for implementation
Tajuddin et al. (2023)	West Nusa Tenggara	Quantitative descriptive	Regional script literacy as compulsory school content	Android educational game (MDLC)	Interest and motivation; perceived user- friendliness
Hakim et al. (2024)	East Java	Quantitative non- randomised	Colonial heritage as classroom history content	Purpose-built mobile learning application (ADDIE)	Product validity, appeal, and effectiveness as judged by experts and users
Yudhanto et al. (2024)	Not reported	Quantitative descriptive	Museum collection interpretation (keris heritage)	Mobile virtual reality virtual museum	User response to interactive media; requirement satisfaction
Yudhawasthi et al. (2024)	Special Region of Yogyakarta	Quantitative descriptive (visitor survey)	Museum communication and collection documentation	QR-code automatic guiding accessed by smartphone	Visitor engagement; quality of information retrieval experience
Zaliluddin et al. (2024)	Not reported	Quantitative descriptive	Local history for adolescent learners	Mobile educational game (Fisher-Yates shuffle, Honeycomb UX)	Historical knowledge; interest; user experience rating
Khan et al. (2025)	DKI Jakarta	Quantitative non- randomised (control group)	Museum heritage interpretation for Gen Z and Alpha	Museum augmented reality mobile application with 3D models	Learning outcomes; engagement, benchmarked against printed materials

Figure 2 displays the annual distribution of the included studies, disaggregated by learning setting. Output was modest in 2021 and 2022, peaked at six studies in 2023, and remained substantial in 2024 before declining in 2025. The composition of that output changed over the period: formal education settings accounted for the whole of the early corpus, whereas museum and informal heritage settings account for the majority of studies published from 2024 onward, indicating a widening of the field beyond the classroom.

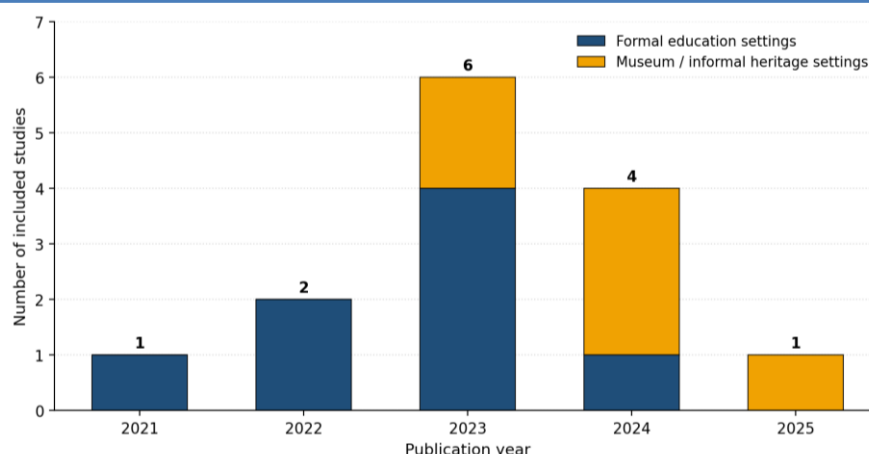


Figure 2. Annual Distribution of the Included Studies by Learning Setting (2021–2025)

Figure 3 maps the geographical distribution of study sites. Bali and the Special Region of Yogyakarta each host two studies, and single studies are situated in West Java, East Java, South Sumatra, West Sumatra, West Nusa Tenggara, East Nusa Tenggara, Southeast Sulawesi, and DKI Jakarta; two studies do not report a study site with sufficient precision to be located. The distribution is notable less for concentration than for dispersion: no province dominates, and the corpus spans Sumatra, Java, Bali, Nusa Tenggara, and Sulawesi. Papua, Maluku, and Kalimantan are entirely absent.

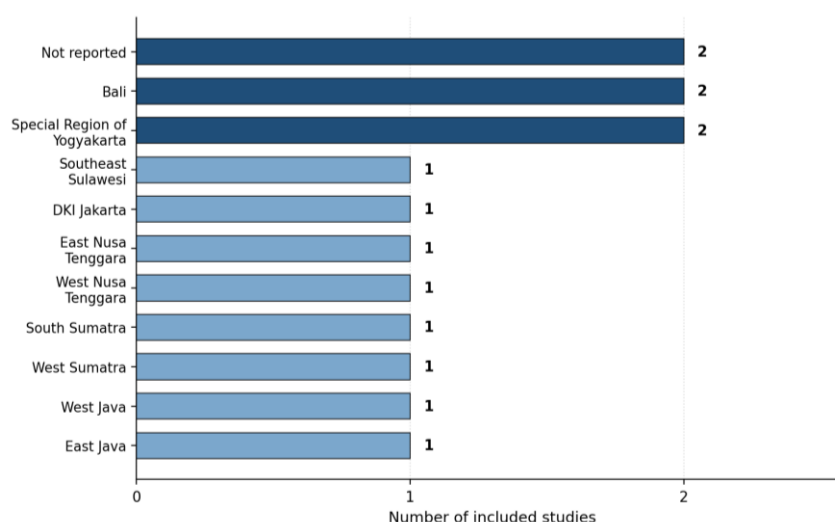


Figure 3. Geographical Distribution of Study Sites Across Indonesian Provinces

Figure 4 summarises the technologies deployed. Mobile augmented reality is the single most common modality, appearing in four studies, followed by purpose-built mobile learning applications in three, mobile educational games and QR-code-mediated access in two each, and mobile virtual reality, a mobile archival repository, and mobile-mediated e-learning platforms in one each. Figure 5 renders the thematic structure of the corpus as four concept clusters, in which usability and user experience (coded in seven studies) and cultural heritage as content domain (also seven) are the most frequently occurring concepts, while learning achievement is coded in five.

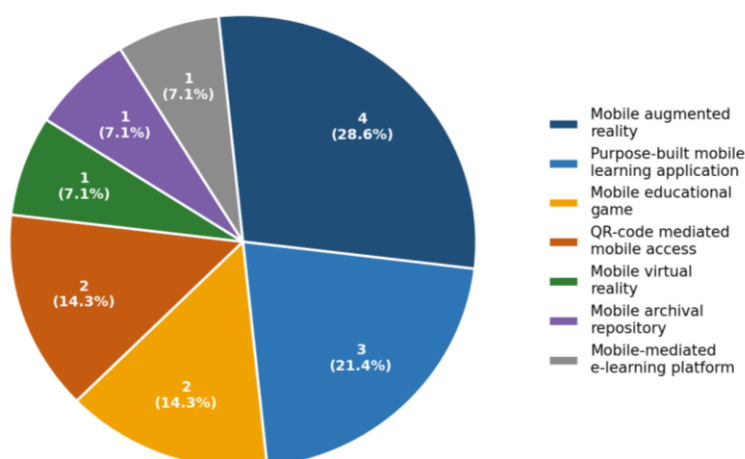


Figure 4. Distribution of Mobile Technology Types Across the Included Studies

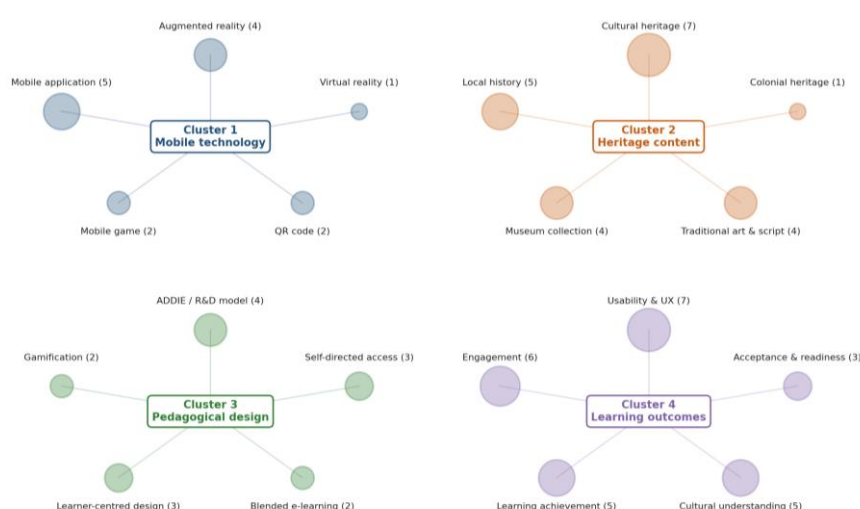


Figure 5. Thematic Cluster Map of Concepts Coded Across the Included Studies

Thematic Synthesis

Findings for RQ1: Characteristics and Trends

The overall temporal profile of the corpus shows a field that, after consolidating rather quickly, reached its peak and remained there. Four out of the ten most recent studies appeared either in 2023 or 2024. The very concentration of these studies in a two-year period, that, at a glance, may seem suspicious of some 'trendy' behavior actually fits the general trend of the spread of easily available augmented reality tools and the normalizing of the device-based mode of instruction during and after the pandemic. The decline one could see in 2025 needs to be carefully interpreted because the time between the actual publishing of the works and their index appearance or open-access deposit is quite wide. Moreover, the restriction of eligibility only to late-stage open-access articles, by definition, significantly shortens the time horizon, particularly that of last year. The main point the data highlight is that this is a fairly new research topic: All the included studies start from 2021 at the latest, with 2023 being the median publication year.

If the first one refers to the chronological aspect, the second main characteristic is the spatial dispersion. The ten provinces where the studies are spread cover five of the main island groups in Indonesia. Furthermore, no single province contributes to more than two studies. Although the fact of dispersion can easily be mistaken as random, in this case, however, it reflects very concrete reasons. Every paper deals with the culture of a specific region. The use of Sasak writing in

Sumbawa, the weaving art of the Sumbanese, the wisdom of the Palembang people in South Sumatra, the Jaipong dance of the West Javanese, and colonial architecture of the East Javanese all exemplify that heritage mobile learning in Indonesia is being approached as a decentralised rather than a centralised strategy. The geographical limitations of the collected works, i.e. the lack of the Papua, Maluku, Kalimantan regions, are important as they are the ones holding significant intangible heritage and they also experience the greatest infrastructural handicaps.

Educational level and setting split the corpus almost evenly. Three studies are situated in higher education, three in secondary schooling, two in primary and basic education, four in museums and other informal heritage venues, and two address general or unspecified audiences. The museum cluster is the more recent, and it introduces a different evaluative logic: where classroom studies assess instructional effectiveness, museum studies assess visitor impact, satisfaction, and engagement, drawing on constructs from consumer and experience research rather than from learning science. This divergence in outcome vocabulary is a persistent obstacle to cumulative comparison across the corpus.

Research design is dominated by non-experimental work. Eight studies are quantitative descriptive, typically surveys or usability evaluations administered after a single exposure; three are quantitative non-randomised, of which only one (Khan et al., 2025) employs a control group with pre- and post-testing analysed by ANCOVA; one is mixed methods (Jamiludin & Darnawati, 2022); one is qualitative (Bramantya et al., 2021); and one reports technical performance only (Maulana et al., 2023). Design-and-development frameworks structure a substantial share of the corpus, with ADDIE applied in three studies and the Multimedia Development Life Cycle and Agile for Virtual Reality in one each. Mean methodological quality was moderate (3.71 of 5, or 74.3%), with seven studies rated high, five medium, and two low.

Findings for RQ2: Technologies, Pedagogies, and Learning Activities

Augmented reality plays the role of a major technological leader in the field, and this leader role it plays in a unique form. In three of the four AR papers under analysis, a marker-based implementation is chosen, a physical trigger which the authors themselves refer here as an item (a single leaf, a lontar, for instance; or a museum label) to anchor the digital overlay on a tangible heritage object (Sudipa et al., 2022; Maulana et al., 2023; Agustini et al. 2023). This design choice is very much in line with an underlying teaching philosophy according to which the learning and the heritage aspects are object-oriented. Hence, in terms of heritage education, Indonesian AR heritage work differs clearly from locationbased approaches which are characteristic of the European heritage-trail research.

The same idea is adopted in the study by Khan et al. (2025), who have placed the 3D models and the interactive content together in a museum gallery, and this is exactly the paper that is based on the sole controlled evidence of learning gain present in the whole corpus. Paper Number 5 discusses that the second cluster of technologies consists of customdeveloped mobile learning apps and educational games. Classroom-based apps generally provide a wellordered set of learning materials, with specific references to the curriculum, much like the local wisdom-based multiple-learning-object design or the colonial heritage application for eleventh-grade social science. Contrarily, the games take the focus off learning content and instead, rely heavily on the power of the gamification engine that makes it fun (e. g., shuffled content through FisherYates algorithm in combination with the Honeycomb principles and game elements developed with the Multimedia Development Life Cycle) A third less dense cluster, however, uses QR codes as a physicaldigital gateway to mobile content. A university jobsheet and a museum guiding system (Purwati et al.; Yudhawasthi et al.

To a large extent, the corpus shows pedagogically little differentiation. It is dominated by models of design and development. In many cases, pedagogies boil down to just presenting the content at

various levels, having expert and user feedback validating the product, i. e., not much of design goes on beyond this level; only, to mention an example, Safitri et al. & Hakim et al. Activities, in the main, are carried out individually and are rather passive, with a focus on reading, watching videos, navigating, and giving answers; collaborative, constructive activities of the learners rarely occur. The one clearly distinct case outside the classroom, however, concerns an oral history project whereby students carry out community testimonial recordings and then place them into an accessible mobile archive. This way they act as historical knowledge creators as opposed to passive learners. The students' activity here not only involves them in a collaborative way but also challenges them in their learning by allowing a certain degree of personal interpretation or argument. (Bramantya et al., 2021). What is more important though, is that no study, to this point, has operationalised such methods of investigation as corroboration, contextualising primary sources and/or the ability to identify perspective-taking, by way of the mobile channel.

Infrastructure emerges as a constraint that shapes implementation as strongly as pedagogy does. Two-thirds of history education students at one institution reported that campus internet and their own devices could not adequately support QR-code-based materials, and senior high school students and teachers in another study identified network problems and the absence of devices as the principal barriers to technology-mediated history learning (Purwati et al., 2023; Jamiludin & Darnawati, 2022). These findings temper the optimism of the development-oriented studies: an application validated as effective under controlled demonstration conditions may not be deliverable in the settings for which it was designed. The corpus contains no study that reports implementation at scale or across multiple institutions.

Findings for RQ3: Effects on Learning, Engagement, and Understanding

The strongest evidence of a learning effect comes from two studies in which learners were assessed prior to and following teaching. According to Safitri et al. (2023), there was a clear redistribution of test grades of students in the History Education Department, as those initially clustering at 10, 55 changed dramatically so that at the end of the course, nine students were in the 86, 100 category, and seven others in the 70, 85 category. Slightly surprisingly, only Khan et al. (2025) reported comparative results.

A museum visitor, who used an augmented reality application was greatly benefited as the learning outcomes and engagement were reported significant when compared to the control group who used printed materials. Data collection was carried out by means of paired-samples t-tests and ANCOVA over two populations each composed of 40 and 86 students. This pair of papers received some of the highest evaluation scores so there seems to be a strong link between methodological strength being reflected by a result. Compared to achievements, engagement and motivation are mentioned much more often, but usually after one-time surveys of perceptions. That said: Tajuddin et.al. (2023) report that 76.67% of the respondents found the game of writing with the Sasak script, and this resulted in an increase in learning interest. Zaililuddin et. al. (2024) mentioned the average level of user experience was 3.75 together with self-reported increases in historical knowledge, and level of interest; Martha et al. (2023) indicated that the usability score achieved was as high as 91% and, what stands out to the reader, is the significant difference observed in understanding 86.7% of the application users understood the subject of Jaipong dance well, while only 33.3% of those who solely relied on video comprehended it. Among these papers that report the findings, the last one gives the corpus of papers the possibility of a formal experiment-free comparative learning claim, although the fifteen pupils involved clearly weaken its validity.

Museum visitor's expected result in such contexts goes from a measure of learning effectiveness or success of the learner, to simply that of a visitor's personal experience of visiting places. For instance, Agustini et al. (2023) showed over 241 visitors that only the quality of augmented reality media content had a direct impact on the visitor effect. System quality and information quality had

only indirect effects by means of mediators rational hedonism and perceived satisfaction. Such an interpretation of the result of such work is a theoretically important outcome inasmuch as it implies in a heritage visitor scenario the interpretive value is more critical the delivery system's technical performance. Yudhawasthi et al. (2024) arrive at a similar conclusion but from a completely different angle, viz. QR-code visitor information systems' ability to engage depends not only on technical quality, but mainly the nature of the information retrieval experience, across such domains as spiritual, educational, recreational, and social dimensions.

Apart from the information presented within the corpus, there is the issue of things that have not been done which deserves a mention. None of the included studies have assessed how long a learner is able to remember the material, not a single study measured learning in an unfamiliar historical context, while none of the operationalised forms of historical thinking have been presented. Only two studies did not even mention learning outcome: one is by Moula et al. (2023) and it is limited to assessment of the distance, angle, and latency of the marker. Another one is by Yudianto et al. (2024) that presents the results of a questionnaire filled in by 40 users but it does not associate them with any educational construct. Both studies were given low scores on appraisal and their exclusion from the effectiveness synthesis wouldn't change its nature. The corpus also has one authentic contradictory result: Jamiludin and Darnawati (2022) state that high school students like to study the history lessons face-to-face and that they perceive the use of computers for learning is limiting rather than empowering, which is totally the opposite to the development studies' uniformly positive tone.

Comparative and Critical Analysis

When we compare the papers together, the methodological differences reflect closely the original disciplines as we expect. For papers published in disciplines closely related to education, the chances of them having a very definite sample, an instructional rationale, and testing before and after administration (pre- and post- measures) is very high. In contrast, papers from engineering and computing backgrounds are less thorough they usually finish their investigations only with user tests and performance benchmarks. It's clearly indicated by the evaluation outcomes where the two studies that got low scores are both engineering venues (development reports) whereas the two perfect 100% scoring ones are a museum survey accompanied by mediation analysis and a quasi-experiment. Therefore, the weakness in evidentiarieness of the field is not due to randomness but rather, has to do with the structure as in where and to whom the article is addressed.

There is one more significant trend identified that relates to the change in methodologies of the included studies over the span of five years. In fact, the oldest studies are very often descriptive, based more on perception, controlled comparison only occurs within the most recent study these suggest that there has been a gradual development from showing what something is capable of doing to estimating the effect. However, the development of the trend is very fragile because in the outside museum survey sample sizes for instance, one usability study had fifteen children, another had forty participants, and not one paper included a randomization procedure, a calculation for power, a report on effect size with confidence interval, or a description of sample size. Another point that is worth mentioning here sensitivity considerations reinforce the above mentioned: in the absence of the two least methodologically confident studies, that change would not have had the same effect that is, the conclusion of synthesis would basically stay the same since none of those two had presented learning-outcome evidence at the outset.

Poorly exploited methodologies have become quite obvious. Besides absence of randomised controlled trial, the corpus does not contain designs as long term/ delayed post-test, design-based research cycles iterated among multiple implementation stages, qualitative observation of mobile classroom where historical sources are actually being reasoned out by the students, cost or scalability analysis, mixed methods have been included only once. If the study with most ambitious methodologies of our corpus is also the paper which shows the clearest effect, it is clear that not

using these controlled and longitudinal designs is a matter of taste, and not a choice, and is thus the main factor that is holding back the field's capacity to declare anything with high degree of certainty.

Interpretation of Findings

Taken together, the corpus describes a field that has tackled the issue it had targeted and is still yet to explore the more challenging one. Using Indonesia as a case study, Indonesian scholars argue successfully that mobile technologies are well-matched to the delivery of historical and heritage content of regionally specific value. They demonstrate that people such as learners and tourists appreciate and are able to use these products, and that the settings from basic classrooms to the most prestigious museums will all be covered. What remains unanswered, though, is the extent of transformation in historical consciousness caused by those technologies over time and under what conditions. The continuous preference for the assessment of usability at the expense of learning as the outcome of primary interest is a defining feature of the discipline. This is why what seems like a uniformly cheerful literature actually draws relatively modest lines of reasoning from that.

Theoretical Implications

Three theoretical implications follow. First, the finding that augmented reality media content quality directly determines visitor impact while system and information quality act only through affective mediators challenges the assumption, implicit across much of the development literature, that technical performance is the principal lever of educational value (Agustini et al., 2023). Interpretation, not infrastructure, carries the effect. Second, the object-anchored, marker-based design shared by most Indonesian AR studies constitutes a distinct theoretical position - heritage learning as encounter with the material artefact - that differs from the location-based and narrative-trail traditions dominant elsewhere, and it aligns with earlier Indonesian work in which the digital layer explicates the meaning embedded in a physical object (Widiaty et al., 2018; Marcellino et al., 2022). Third, the near-total absence of historical thinking constructs indicates that the field has borrowed its theoretical apparatus from human-computer interaction and technology acceptance rather than from history education, which constrains the questions it is able to ask.

Practical Implications

For teachers and teacher educators the evidence favors the use of mobile applications as tools to offer students object-rich, regionally-specific heritage content and as an alternative to the poor coverage offered by textbooks; however it also discourages the replacement of whole expository instruction; in the sole student preferences based study direct classroom teaching was clearly preferred (Jamiludin & Darnawati, 2022). To museum professionals from the strongest available evidence the practical priority has emerged as the investment in quality of interpretive content (i.e. content delivered in the form of narrative, 3D fidelity and contextual explanation) rather than in platform sophistication (Agustini et. AL., 2023; Khan. al., 2025). Developers need to be warned by the results of the readiness survey that their products should not assume that optimal conditions are prevalent. Only about one third of students surveyed at a university reported that Internet access and device capabilities could run QR-based materials. Hence, designers could look into solutions that do not depend on being online and consume very little bandwidth (Purwati et. al., 2023). To a certain extent, funding should be directed to under-represented regions with heritage transmission pressure that may explain that the distribution of the corpus on the provincial level does not take into account the regions from eastern Indonesia where heritage transmission pressure is the greatest from the absence of eastern Indonesia data (Jusoh, 2019, p. 15).

Comparison with Prior Reviews

The only directly comparable synthesis in this literature is bibliometric rather than evaluative, mapping publication patterns, institutional activity, and keyword structure at the intersection of e-learning, culture, and tradition, and reporting that mobile learning, augmented reality, and cultural heritage are among the most prevalent terms (Yuki et al., 2025). The present review is consistent with

that mapping at the descriptive level while departing from it substantively: bibliometric prevalence of a term does not establish evidential strength, and the appraisal reported here shows that beneath the keyword density lies a corpus in which only one study employs a control group. Related work evaluating digital heritage platforms, batik-focused digital technologies, and smart-tourism applications at major heritage sites similarly documents proliferation without evaluating instructional effect (Permatasari et al., 2020; Permatasari et al., 2023; Nurcahyo et al., 2025). The contribution of this review is therefore to convert a picture of activity into a picture of evidence.

Contradictions in the Literature

The corpus contains three genuine tensions. The first is between reported enthusiasm and reported preference: development studies consistently report favourable user responses, while the one study surveying students about technology-mediated history learning at scale found a preference for face-to-face instruction and experienced technology as a constraint (Jamiludin & Darnawati, 2022). The most plausible reconciliation is that novelty-bound evaluation of a single well-supported artefact measures something different from sustained experience of under-resourced remote instruction. The second tension is between technical and interpretive determinants of impact: development studies optimise system performance, whereas the largest survey in the corpus finds system quality has no direct effect (Agustini et al., 2023; Maulana et al., 2023). The third concerns readiness, with some studies presupposing device availability that other studies explicitly document as absent (Purwati et al., 2023).

Research Gaps

Putting together our findings, the corpus reveals a number of interrelated weaknesses that limit the field's development. To begin with, the measurement of outcomes of mobile learning is confined largely to recall of knowledge, usability, and user satisfaction since there is no operationalisation of the main concepts of historical thinking such as source evaluation, temporal reasoning, and historical empathy in the studies we reviewed. This lack of conceptual clarity is matched by methodological flaws: only one of the studies is experimental control group-based; no study is randomised, one reports effect sizes or power analysis, and one is retention measured beyond the immediate post-test. Such conditions together undermine the robustness or even the truthfulness of the effectiveness claims that have been made so far through the literature. In instruction design, it was found that individualized and passive models dominate the mobile activities studied. Collaborative, inquiry-based methods, and pedagogical designs in which students act as "makers", that are in fact the main focus of contemporary history teaching, are nearly completely absent. Such a deficit is also apparent from a geographical and institutional point of view: Papua, Maluku, and Kalimantan are not represented at all in the corpus of reviews and none the studies report on the cross-institution or system scale implementation, hence making the findings not transferable regionally or structurally. In the end, the aspect of sustainability is still underdeveloped; no study deals with teacher professional development, pedagogical content knowledge and mobile-based heritage learning conditions in post-project scenario which is a shortcoming since it is the teacher's competence that makes a sustainable intervention, not technology alone. When viewed as a whole, those five areas lacking point out that the discipline of mobile history and heritage education learning in Java has not yet graduated from a pioneering phase where the emphasis lies more on technical feasibility and user acceptance, but it is not a time period that includes evaluation that is methodologically sound, pedagogically advanced, geographically broad, and institutionally sustainable.

Limitations of This Review

Four limitations qualify these findings. First, the review drew on a single database. Scopus indexes the principal outlets for this literature and supplies the structured metadata required by the eligibility criteria, but restricting retrieval to one source will have missed relevant work indexed only in Web of Science, ERIC, or the Indonesian national databases, and Indonesian-language scholarship

is excluded entirely by the language criterion. Second, the eligibility criteria were deliberately restrictive. Limiting inclusion to final-stage, open-access journal articles removed 90 conference papers, several of which - including work on mobile role-playing games for historical learning, serious games reconstructing national events, and augmented reality temple-relief storytelling - address the review questions directly and are cited in this manuscript as context (Kusuma et al., 2021; Rinaldi et al., 2022; Kurniawardhani et al., 2024). Conference proceedings carry substantial weight in Indonesian computing research, so this restriction trades coverage for consistency of peer-review standard.

Third, screening, extraction, and appraisal were performed by a single reviewer. No inter-rater reliability coefficient could therefore be calculated, and the possibility of selection and appraisal bias cannot be excluded; the mitigation adopted - documenting an exclusion reason for every removed record and returning to full texts to resolve borderline cases - reduces but does not eliminate this risk. Fourth, no protocol was registered prospectively, and the small final corpus of fourteen studies, combined with heterogeneous outcome measures and the absence of comparators in most studies, precluded meta-analysis and any formal assessment of publication bias. Conclusions about effectiveness therefore rest on a narrow evidential base and should be treated as provisional.

Future Research Agenda

Building upon the identified research lacunas, the future research agenda for mobile learning in Indonesian history and heritage education should cover five interconnected areas. First, and most importantly, the field should carry out comparative controlled studies that include pre-test, immediate post-test, and delayed post-test measurements at four to eight weeks, with effect sizes and confidence intervals given as standard output results. Indeed, the Khan et al. (2025) paper should be seen as a minimum standard methodological benchmark rather than a unique case. Secondly, the research community has to take to task the implementation of validated instruments of historical thinking source corroboration, contextualization, and perspective-taking and adapt them to the Indonesia curricular context, thereby mobile heritage learning could be evaluated through the substantive purposes of history education instead of generic usability heuristics.

Thirdly, future projects of great interest and research are to be carried out on the design and test of learner-generated and collaborative activities that involve students in gathering, curating, and interpreting local historical sources with the help of mobile devices. One of such oral history methods demonstrated by Bramantya et al. (2021) will become the template to move such community-based approaches directly to the formal school setting. Besides, multi-site implementation research is highly desirable in currently under-represented areas of eastern Indonesia provinces with specific focus being given to offline functionality, device availability and bandwidth limitations, as revealed through readiness studies in the field (Purwati et al., 2023). Lastly, but equally crucial is, future research needs to study the adoption factors from a teacher's perspective-professional development, curriculum integration, and post-project sustainability-scope which so far had been totally ignored within existing literature, yet without these factors, classroom implementation of the technology is unlikely to survive after a period of individual project lifespans. If this program is executed, collectively, the field will be transformed from a proof-of-the-concept stage to one producing scientifically rigorous, pedagogically meaningful, and sustainable evidence which will inform decisions made by policymakers as well as the practices of educators in the area of teaching Indonesian history."

Summary Answers to the Research Questions

RQ1. Research on mobile learning in Indonesian history and cultural heritage education is a young and geographically dispersed literature of fourteen open-access journal studies published between 2021 and 2025, concentrated in 2023–2024, distributed across ten provinces in five island groups with eastern Indonesia unrepresented, split between formal education (eight studies) and museum or

informal settings (four), and dominated by quantitative descriptive designs; only one study employs a control group, and mean methodological quality is moderate at 74.3%.

RQ2. Implementation centres on mobile augmented reality (four studies), predominantly marker-based and anchored to physical heritage objects, followed by purpose-built mobile learning applications (three), mobile educational games (two), QR-code-mediated access (two), and single instances of mobile virtual reality, a mobile archival repository, and mobile-mediated e-learning platforms; pedagogically the corpus is dominated by ADDIE-type development models delivering individual, receptive activities, with collaborative and inquiry-based designs almost entirely absent and infrastructure constraints repeatedly limiting deliverability.

RQ3. Where learning was measured before and after instruction, mobile learning produced substantial gains in achievement and, in the single controlled comparison, significant improvements in both learning outcomes and engagement relative to printed materials; engagement, motivation, usability, and satisfaction were reported positively across the corpus, and interpretive content quality rather than system quality was found to drive impact in museum settings; however, retention, transfer, and historical thinking were nowhere measured, two studies reported no learning outcome at all, and one large survey found students preferring face-to-face history instruction, so the evidence supports claims of short-term engagement and knowledge gain but not claims about durable historical understanding.

CONCLUSIONS

This review, which included 14 open-access papers in peer-reviewed journals between 2021 and 2025, reveals that mobile learning research at the intersection of Indonesian history and cultural heritage education is still in its infancy. The research is spread across ten different regions, and most of it is descriptive or development-based, with a single controlled comparison study, resulting in an overall moderate methodological quality. Mobile marker-based augmented reality at a physical heritage object has been an implementation method besides custom-designed educational mobile applications, games, and QR code-mediated access, through mostly individual and receptive learning activities. Engagement, usability, and short-term knowledge retention were consistently reported effects, while the interpretive content rather than the technical features seemed to be the most influencing factor of the impact. Retention of knowledge, its transfer, and development of historical thinking, however, were not measured. As the review provides the first evidence map of the field, practitioners can use it as a design and investment guidance. However, due to the single-database, restrictive eligibility criteria, and single-reviewer methodology, this research is limited. At last, further controlled comparative design, long-term as well as high-quality educational research will be a necessary step.

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